Non euclidean geometries explained

The geometry we are taught in most of the schools and other institutes of education is the geometry we all know, but not all 2D geometries are Euclidean, there are also two other types of two-dimensional geometries, they are :

1. Spherical geometries

And

2. Hyperbolic geometries

Note : all geometries talked about in this paper will be 2-D ones

First, let us first discuss what is Euclidean geometry. It is the geometry that Euclid explained and recognized. It is the geometry we are all used to. We are taught about in schools and colleges. We frequently see this geometry in our day-to-day life. It is one of the most fundamental geometries that is used in all sorts of calculations. It is used in everything from calculating trajectories of rockets to figuring out how much land can be acquired for how much wealth, etc. let us take a look at how various objects behave in this geometry.
Basics of geometry :
Planes:
They are the very essence of 2D geometry as all shapes and geometrical objects exist on a plane. A plane is an infinitely extending flat two-dimensional surface. They usually have different formal definitions, so, we will use the simplest one.
Points :
A point is an object with no dimensions, no width or height. A dot is the smallest object that can be drawn by a pen, pencil, etc, so, we use a dot to represent the idea of a point.
Rays: rays start at an origin point and then are followed by an infinite series of points in one direction. They have a starting point but no end point, giving it one end point. Yes, an end point can also include a starting point as well as an end point.
Angles : angles are formed when two rays start from a common origin point. The angle is formed between the two rays. The unit of measure of angles is, in common life, degrees. There are also different types of angles, here are some of them :
- Right angles, these are probably one of the most common angles in our lives, we are surrounded by rectangles and squares, containing four of them. Right angles are the angles that have a measure of EXACTLY 90 degrees.
- Obtuse angles, they measure more than 90 degrees, but less than 180 degrees.
- Acute angles : they measure more than zero degrees but less than 90 degrees.

- Straight angles are the angles that measure EXACTLY 180 degrees.
- Reflex angles are the angles that are more than 180 degrees but less than 360 degrees.
- Full angles are the angles that go fully around, measuring 360 degrees.

Lines :

A line is an infinite series of points that extend outward in both directions infinitely. Two lines that will never meet each other are called parallel lines, two lines that meet at a point(known as the point of intersection) are known as intersecting lines. Lines that intersect at an angle of 90 degrees(right angle) are known as perpendicular lines.

Lines segments:

Lines segments are parts of lines that have only a finite length. They can also be defined as the shortest path between two points that are on the same plane.

Shapes:

Shapes are a 2D figure that are, in some way defined by a boundary or outline, separating them from the rest of the plane. In two-dimensional geometry, shapes have a height and width, they are the measures of both the directions that can be moved in two-dimensional geometry. They have an area, which is the amount of space that is enclosed inside the boundary of the shape. Polygons are 2D closed figures made up of at least three line segments that are joined together, making a closed figure. A quadrilateral is a polygon that has four sides. To calculate the are of a simple square, just multiply the height and the width and turn the original unit into a square unit. This also works for rectangles, just, with squares, all their sides are equal, meaning, if the length = *x*, then the area = x times x, meaning just x squared, which, by the way, is why we call raising to the power of two, well… squaring.

Spherical geometry

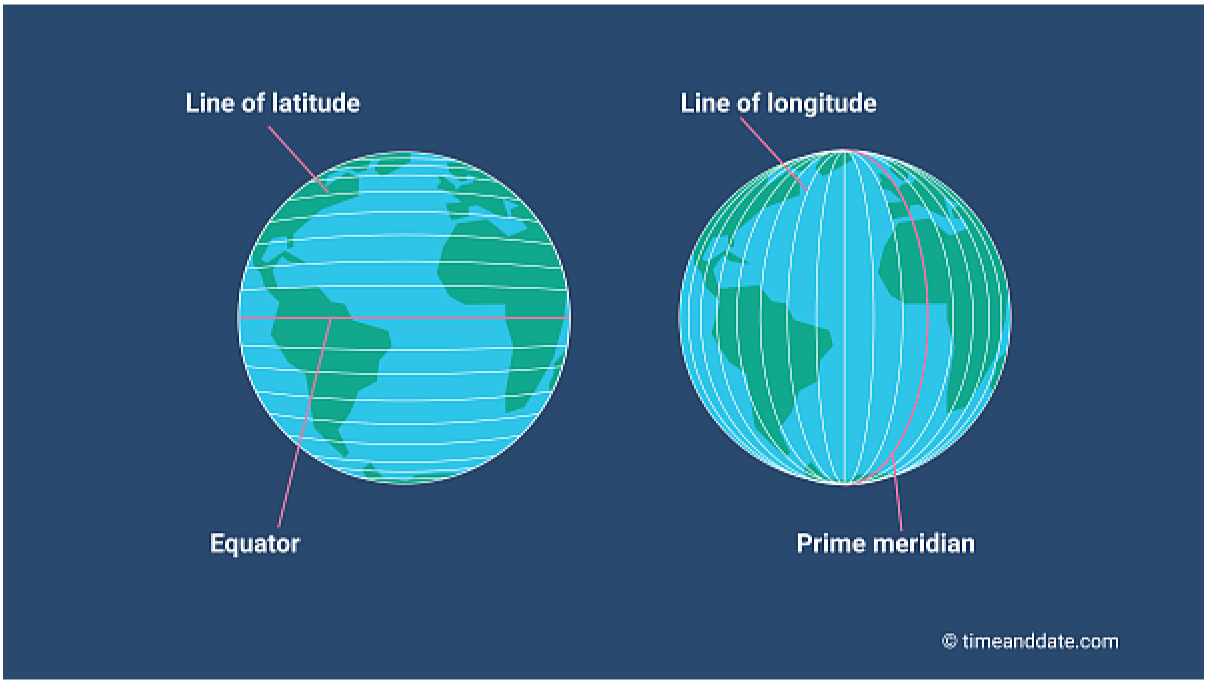
So, now that we know about the core basics of geometrical behavior in Euclidean geometry, let us move on to the next geometry, which, is, ironically, the one we live on. It is… Spherical geometry, now, you must be shaking your heads saying that, “Well, I thought you were going to only talk about two-dimensional geometries, a sphere is not two-dimensional.”.

So, dear reader, let me take a moment to clarify that, while, you are right that a sphere is a 3D object, we are not talking about the whole sphere, just the 2D surface of the sphere. So, now that the previous doubt has been clarified. Let us continue with geometry basics in a much more “UNUSUAL” realm. This is Spherical geometry. You see, spherical geometry exists, well, on the surface on a sphere, in other words, it can be defined as a geometry that describes the behaviors of objects on the surface of a sphere. It operates very differently than ours. Let us learn about it.

The rules are extremely similar, but, with a few key changes from Euclidean geometry, they are listed below.

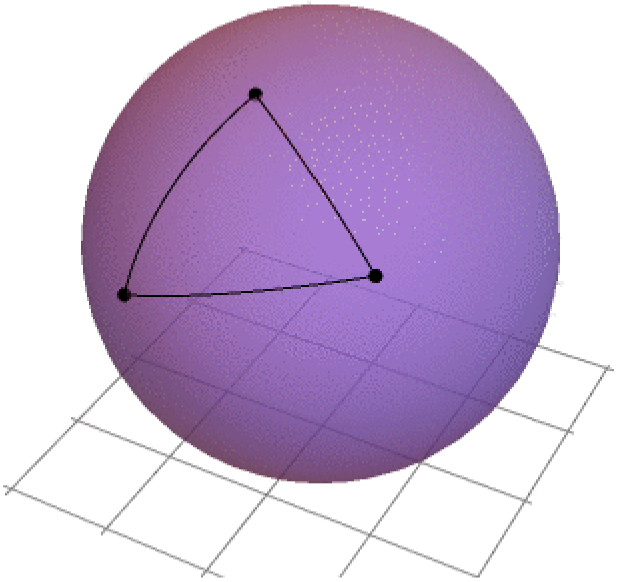
1. Parallel lines : There are no parallel lines in Spherical geometry. To understand this, let us suppose you and your friend, both armed with supernatural powers,

decide to walk in a straight line(from your point of view) from the equator, to see if you will ever meet, and hence, if parallel lines exist in spherical geometry. If you ever meet, that means that they do not exist, and if they do exist, you will never meet. So, you start walking, and after walking approximately a fourth of the circumference of the Earth, at one of the poles of the Earth, then, if you continue walking, you would meet again at the other pole of the Earth, you were walking alone one of the longitudinal lines of the Earth, which is a type of Geodesic. Here is an illustration to help you understand



Here, every line of longitude and latitude are geodesics, if you go to the surface, they would look like parallel lines, but all of them meet at the poles. Hence, parallel lines do not exist in this type of geometry.

Triangles – As we all know, triangles' angles always add up to 180 degrees in Euclidean geometry, nut, in spherical geometry, due to the curvature of the surface, in this geometry, triangles' angles can only add up to be greater than 180 degrees. Here is an animation:

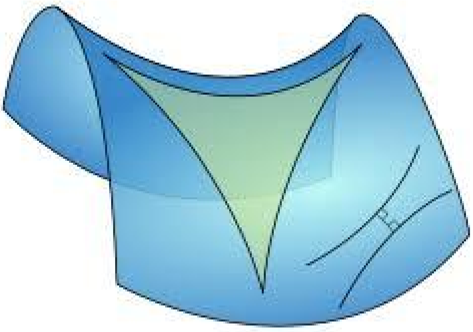


Hyperbolic Geometry

Now, let us move onto a truly foreign and unknown geometry, and for real this time, this is a geometry that maybe you have only seen on the surface of Pringles™. It is one of the most weird geometries that exists, where you can have an infinitely long triangle with angles adding up to less than 180 degrees, and with a finite area, sounds impossible, right, but, in this geometry, it is not. Let us learn about it.

Differences:

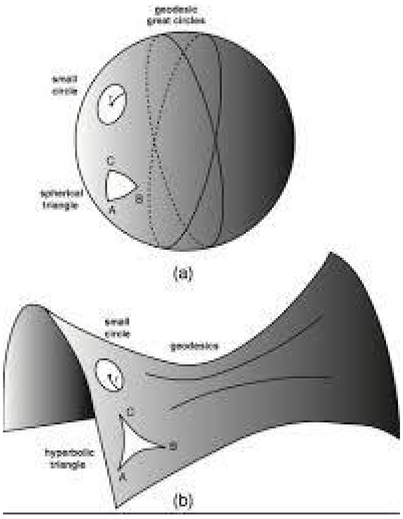
Triangles: as discussed earlier, triangles in this geometry can be infinitely long, with finite area, this is possible due to the reason that the curvature of the geometry brings them close together(the lines that make up the sides of the triangles). Here is a illustration:



Here, as the triangle continues, its sides will converge into one line, hence, they will contribute no area,but will contribute to the length, and hence there is a finite area will be achieved.

Parallel lines:

In this geometry, parallel lines appear to be curved, but they do exist. if perfectly in the center they will appear to be straight, but, due to the curvature of the geometry, the lines parallel to that one will appear to be curved, but, if you straighten the geometry apart, then you will see that they are just parallel lines in euclidean geometry. Here is an illustration:



please focus on hyperbolic geometry’s parallel lines

THANK YOU